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Guided cell repopulation in periodontal therapy utilizing absorbable barrier techniques

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Purpose

The purpose of this clinical update is to review bio-absorbable materials currently marketed as barrier membranes in guided cell repopulation techniques in periodontal therapy.

Introduction

Healing of periodontal defects can be a complex process. Ideally, the goal of surgical therapy is to regenerate lost structures, namely cementum, periodontal ligament (PDL) and alveolar bone. The cells that repopulate the root surface after surgery tend to determine the type of attachment that is formed (1). Epithelial cells generally migrate first into the surgical site, but they form an epithelial attachment. **Guided tissue regeneration (GTR)** uses a barrier membrane to exclude epithelial cells and gingival connective tissue (2). This favors regeneration of lost tissue by promoting cell repopulation from the PDL and adjacent alveolar bone. **Guided bone regeneration (GBR)** is a technique that evolved from GTR principles and is specifically designed to reconstruct alveolar bone defects for the placement of dental implants (3,4).

Nonabsorbable barriers made of expanded polytetrafluoroethylene (ePTFE) (like Gore-Tex®) are considered the 'gold standard' by which other barrier membrane systems are compared. Their primary disadvantage is that they must be removed after the appropriate healing time necessitating a second surgical procedure. Absorbable barriers were introduced to overcome this problem. Currently available materials include collagen, polygalactin, and polylactic acid.

Discussion will focus only on those materials in wide-scale clinical use.

Collagen

Collagen membranes can be described in several ways. There are two main subtypes of collagen (Type I and Type III) used, two main animal sources (bovine and porcine), and the collagen can be harvested from tendon or dermis. Barrier membranes are made by an extrusion-coagulation of dilute (<1%) collagen solutions, which are air dried to form sheets. Cross-linking in the collagen molecule extends the absorption time, typically 6-8 weeks for use in periodontal defects, and reduces antigenicity. This is clinically pertinent since membrane resorption parallels the formation of new bone, cementum, and periodontal ligament in early wound healing.

As a barrier membrane, collagen has these advantages (5):

1. Hemostatic properties
2. Chemoattractant for fibroblasts
3. Acts as a lattice for migrating periodontal ligament fibroblasts
4. Easily shaped and is readily adaptable to root surfaces
5. Low antigenicity/weak immunogen
6. Bioabsorbable, eliminating the need for surgical removal

Clinical trails using bovine type I collagen (tendon and dermis) barriers for GTR procedures in Glickman grade II human furcation defects showed results comparable to those of ePTFE nonabsorbable materials (6). Sites treated with collagen barriers demonstrated greater improvement in vertical defect fill, percent defect resolution, and horizontal furcation fill when compared to open flap debridement therapy alone (7, 8).

Despite their widespread use, clinicians must remember that any protein has the potential to elicit immunologic and inflammatory reactions. The type and source of collagen used in the barrier seems to be the most important variable in antigenic response. Tendon-derived collagen appears relatively inert after extensive testing.

Commonly used collagen membranes are:

BioMend®: indicated for GTR procedures in periodontal defects; fabricated from **bovine** type 1 collagen from deep flexor tendon; can be placed dry or hydrated with sterile saline; can be sutured in place if needed; fully resorbed in 4-8 weeks.

BioMend XT®: indicated when extended duration of barrier function is desired; thicker and more tear resistant; can be tacked in place for stabilization; fully resorbed in 18 weeks.

Bio-Gide®: indicated for GBR procedures with implants, localized ridge augmentation, socket preservation and large defect fill; fabricated from **porcine** type I and III collagen; has a bi-layer structure and is placed rough side towards the bone, dense side marked with "UP" towards soft tissue; can be sutured or tacked in place if needed; fully resorbed in 6 months.

OSSIX®: indicated for GBR procedures with implants, localized ridge augmentation, socket preservation and large defect fill; fabricated from **bovine** type I collagen from deep flexor tendon; can be sutured or tacked in place if needed; membrane resorption begins after 6 months and is completed by 8 months.

Synthetic Polymers – Polylactic Acid and Polyglycolic Acid Polymers

Degradable polymers constitute the other major group of bioabsorbable barrier materials. They are formed by copolymerization of different forms of polylactic acid (PLA), polyglycolic acid (PGA), or mixtures of both. Degradation occurs via hydrolysis of ester bonds that requires approximately 30 to 60 days or more depending on the polymeric composition of the material. Most clinical studies indicate that polymer barriers demonstrate comparable results to other GTR barriers including ePTFE (8, 9, 10, 11).

There are five major bioabsorbable polymer barriers that are indicated for GTR procedures in periodontal defects on the market:

Vicryl®: fabricated as Polyglactin-910 mesh composed of an inert synthetic copolymer of glycolide and lactide; available in woven or knitted mesh which has larger pore size and is reported to have better handling characteristics than solid sheets. It is sutured in place for stability. Resorbs via hydrolysis over a period of 3 to 12 weeks.

ATRISORB®: fabricated as a synthetic liquid polymer consisting of lactic acid, poly(D,L-lactide)(PLA) dissolved in N-methyl-2-pyrrolidone (NMP). Since it partially polymerizes when in contact with water, it to can be prepared extraorally, then cut and shaped for customized intraoral adaptation. The material undergoes a rigid set and is self-adhering, so it does not require suturing. Resorbs via hydrolysis over 9-12 months.

ATRISORB-FreeFlow®: It features an alternative in situ placement technique: flow the Atrisorb® polymer onto and over the graft filled

defect, allow it to fully set in the fluid environment. Resorbs via hydrolysis over 9-12 months.

ATRISORB-D®: free flow barrier product that incorporates the antibiotic doxycycline.

RESOLUT XT®: fabricated as a porous structure of synthetic glycolide and trimethylene carbonate copoplymer fiber with an occlusive membrane of synthetic glycolide and lactide copolymer. Designed to be stiff enough to create and maintain space, yet flexible enough to drape smoothly over the defect margins. Remains essentially unchanged for 8-10 weeks then gradually resorbed via hydrolytic and enzymatic pathways.

Epi-Gide®: fabricated as a hydrophilic membrane formed from D, D-L, L-polylactic acid. Contains a flexible open cell structure which contributes to blood uptake and adherence, and internal void spaces that facilitate blood clot formation. It also has a density-gradient three-dimensional construction designed to attract and retain fibroblasts and epithelial cells while maintaining space. Remains essentially unchanged for 6-8 weeks with complete resorption occurring between 6-12 months.

Gore Resolut Adapt®: fabricated from a fiber web composed of copolymers glycolide (PGA) and trimethylene carbonate (TMC). The open-web structure allows for tissue integration, facilitating stabilization of the wound. Provides barrier function for 8-10 weeks and then resorbs via hydrolysis.

Other bioabsorbable barriers:

Capset®: also indicated for socket preservation. Fabricated as medical grade calcium sulfate. Manufacturer claims the advantages of excellent tissue response, low incidence of infection if exposed early, good adaptation and adherence to root surfaces, and shorter chair time. Remains intact for 2-6 weeks depending on level of fluid contact and degree of exposure. Main disadvantage is early loss of barrier function if exposed, therefore must obtain primary closure and remain covered by soft tissue throughout the healing period (12).

Summary and Future Directions

The bioabsorbable barrier membranes outlined in this review differ in composition, handling characteristics and biologic response. Clinical research has been done on most of them, comparing them favorably with nonabsorbable ePTFE membrane, the current 'gold standard' (6, 9, 11), while offering the advantage of not requiring a second surgical procedure for removal. As in any GTR/GBR procedure, a successful outcome depends on proper case selection, good surgical technique and patient compliance. Future research in bioabsorbable materials may be focused on utilizing these barrier membranes for the delivery of growth factors and other modulators of wound healing to enhance regenerative outcomes.

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